ARADS: Atacama Rover Astrobiology Drilling Studies

Completed Technology Project (2015 - 2019)

Project Introduction

Mobile exploration of the subsurface is essential in achieving future astrobiology goals. Discovery of volatile organics and perhaps life on Mars is unlikely without the ability to access the subsurface. Many of the goals of NASA's planetary science program require mobile surveys sampling of dry or ice-bearing regolith or bedrock and sample transfer to instruments. Several future planetary exploration missions call for this, including the proposed ExoMars rover in 2018. Lightspeed delays for Mars missions (tens of minutes) are much longer than the time required (seconds) to get a drill stuck, so deep space rover drilling operations must be automated and fail-safe, or else risk anchoring the rover. Obtaining subsurface samples of regolith will require the ability to identify a suitable location, transport and emplace a drilling apparatus, and control the operation with high reliability. We propose a Mars rover analog mission as a field test of an integrated rover-drill system with prototype instruments that are flight mission candidates. Depth and sample volume requirements for scientific sample acquisition impose the need for a drill capable of penetrating depths of a meter or greater. Observing the operation of the rover/drilling system in a high fidelity environment illuminate the difficult issues of low-gravity drilling into an unknown substrate, drill site sensing and selection, and drill system emplacement and stabilization. The existing LITA (ASTEP) -derived Icebreaker-3 rotary-percussive drill system, and a new autonomous mid-sized rover concept (K-REX) developed by NASA-Ames, are available and compatible for the integration required for an analog site field experiment. Three of the four proposed instruments, and the drill, are currently part of the Icebreaker Discovery mission proposal. The essential elements to the proposed experiment are: 1) use of integrated drill and rover at sites in the Atacama Desert in Chile in unprepared "regolith"; 2) field use of instruments with the rover/drill that are flight prototypes comparable to those planned for ExoMars and Icebreaker; 3) acquire drilled cuttings and transfer to instruments; 4) on-board autonomy and monitoring to support drilling; mission and demonstrate science support (operations and control) for the rover/drill/instrument operations. The motivating goal behind the Mars Exploration Program is the search for evidence of extant or extinct life (e.g. MEPAG, Decadal Survey, Astrobiology Roadmap). The cold and dry conditions on Mars open the possibility that evidence for life may be well preserved in the form of organic biomarkers. Even without biological production, organics should still be present on Mars due to the flux of organic bearing meteoritic material. Three missions have tried to detect organics on Mars: the pyrolysis GCMS on Viking, the TEGA on Phoenix, and the Sample Analysis at Mars (SAM) suite on Curiosity. In these instances the soil samples were heated to high temperatures to cause vaporization of organics allowing detection. The recent discovery of perchlorates in the soil suggest strong oxidants including perchlorate caused organic oxidation to CO2 prior to detection. A reanalysis of Viking results suggest that ~0.1% perchlorates and a few ppm of organics were present at the Viking landing sites. The proposed ARADS rover/drill combination, operating on the perchlorate-bearing desiccated soils of the

ARADS: Atacama Rover Astrobiology Drilling Studies

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

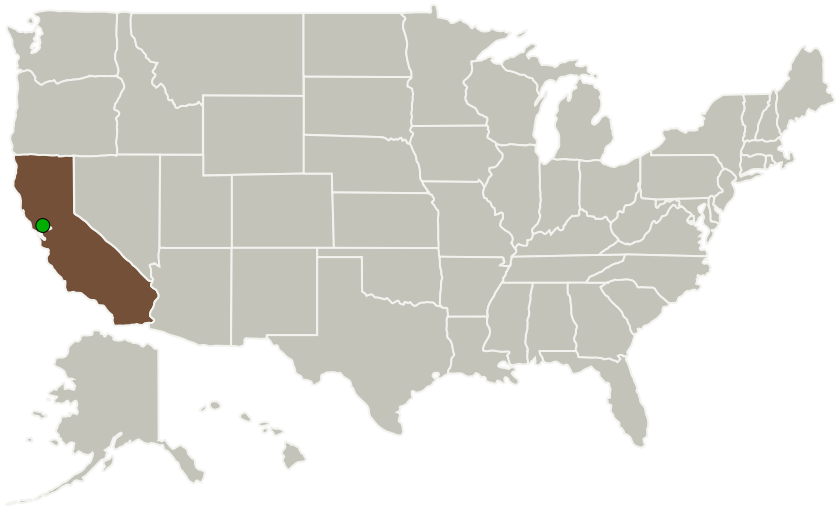
Planetary Science and Technology Through Analog Research

ARADS: Atacama Rover Astrobiology Drilling Studies

Completed Technology Project (2015 - 2019)

Atacama analog site, will provide high-fidelity sample collection and science opportunities to test these detection methods. The ARADS experiment will demonstrate the feasibility of roving and drilling missions to Mars and show the science value of such a mission in the search for a record of life. It will demonstrate biomarker detection technology that is a candidate method for flight on future missions, in a realistic science operations simulation.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Carolyn R Mercer

Program Manager:
Sarah K Noble

Principal Investigator:
Brian J Glass

Co-Investigator:
Robert A Duffy

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.4 Sample Acquisition and Handling

Target Destination

Others Inside the Solar System